WOOD
IN THE SERVICE OF
MAN

A review of research during 1970-1971 at the Forest Products Laboratory
Forest Service, U.S. Department of Agriculture

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MAN

U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FOREST PRODUCTS LABORATORY

MADISON, WISCONSIN

FOREWORD

I have just finished re-reading the History of the Forest Products Laboratory—a fascinating story that dates back to 1910. It is much more than a history of an institution, however, for its pages tell of a changing timber supply, changing consumer needs, and a changing industry. It is a story of new laboratory findings, a period of sometimes painfully slow adoption and finally full acceptance by industry and the public. There are many voices in the pages of the book, and I have been struck with the recurring theme—the need for wiser and more complete use of the wood resource. The voices are still with us, but they are louder now. Anyone who does not hear them is simply not listening. There is a growing awareness that wood—a renewable resource—can solve the imminent future material shortages.

This report presents some Laboratory findings—findings of no importance until they are put to use. Perhaps, if we are listening, the implementation will be much more rapid than it has in the past. The age of wood lies ahead.

H. O. FLEISCHER
Director

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Introduction

Wood, one of man's most useful and versatile raw materials, can be uniquely beneficent in its environmental and ecological impacts. It can be harvested with little lasting impact on ecological conditions; for every mature tree harvested, another can be grown, renewing the resource. Likewise, it can be processed into thousands of consumer goods with byproducts either themselves potentially usable or easily disposed of under environmentally harmonious conditions. And when a wood product's usefulness is ended, it can be recycled for another use or returned to the organic cycle from which man borrowed it.

It can be. Which is not to say that it is, or that all necessary technology now exists to make it so. One of the primary missions of FPL research is to find those techniques, processes, and practices that will attain these wood utilization goals with as little environmental or ecological disturbance as humanly possible while maintaining a flow of needed products to a growing population.

This research review for 1970 and 1971 recounts a number of solid FPL contributions toward fulfillment of that mission. It is not, however, to be construed as a catalog of FPL research programs. For every research advance described here, numerous others more or less closely related are in many stages of development.

BOF: It could mean More Lumber Per Log

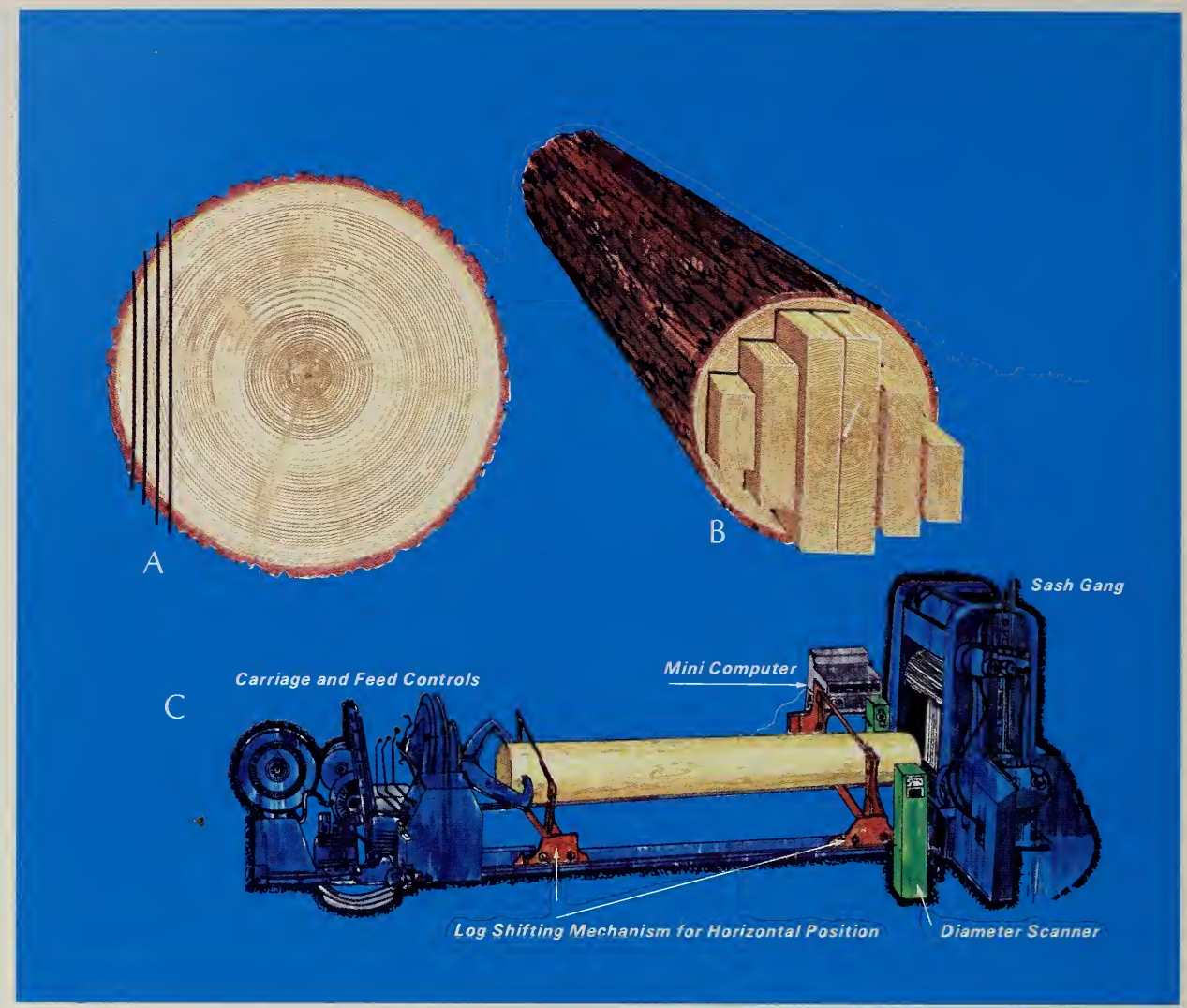
As experience with Operation Breakthrough proposals has once again clearly demonstrated, wood and its products—lumber, plywood, particleboard, fiberboard, etc.—are indispensable building materials without which national housing goals would be far more difficult of attainment. Any system of sawmilling that promises more lumber from a given number of logs, therefore, has great significance for every citizen, be he concerned with housing, or the wise use of our forest resources, or the environmental impacts of pollutive residues.

BOF is such a system. From the smaller, largely second-growth timber now increasingly coming to sawmills in all regions, it offers the potential of extracting up to 10 percent more lumber, on the average, than mills now cut. It does this by producing not more but larger pieces from a log of given diameter—thereby putting to its most valuable use wood that otherwise would be trimmed off in cutting square-edged lumber from the cylindrical log. Such trims, of course, are mostly either chipped for lower-value pulp or consigned to fuel burners.

Some 7 billion board feet of western softwoods and 8 billion feet of southern pine are produced from small and second-growth logs annually; so the BOF potential is vast and growing.

BOF is an acronym for Best Opening Face. The name was coined to emphasize the critical importance, in terms of maximum yield, of the first or opening sawcut on a log. A complex maze of computer computations has shown that where this cut is made can mean a yield difference of up to 100 percent, with the average of most sawmilling methods around 20 percent. Since any given mill can be assumed to make by chance an opening cut somewhere between the low and high extremes, an average improvement of 10 percent is assumed for the BOF system.

Principal equipment needed for a mill to put BOF in operation includes a minicomputer, an electronic scanner, and numerically controlled



BOF, the new FPL sawmilling concept, develops the Best Opening Face (A) for a log of given diameter to assure maximum lumber output and least edging residue (B) by means of special computerized equipment (C).

motor-operated log-positioning setworks accurate to 0.002 inch. All are commercially available. It is estimated that mills cutting upwards of 40,000 board feet a day can make economic use of the system and return the installation investment of something less than $100,000 in the first year.

The minicomputer is programmed with the best opening face information for each log diameter. This input information is developed on a computer of adequate capacity by a program which the FPL has developed. Considered in this program are such elements as dry lumber sizes, drying shrinkage, planing allowances, saw kerf width and normal sawing variation of the particular mill.

BOF is applicable to any mill currently using any of three sawing methods in common use. These are the variable-face-opening flitch system and the centered-cant and variable-face-opening cant systems. Two other systems, the centered-flitch and centered-sawline, are not adaptable as is, although mills using them can be switched to BOF.

Recycling: Renewal of a Resource

In the autumn of 1971, a unique pilot plant designed and operated by FPL scientists began recovering for reuse some of the municipal trash otherwise hammermilled to bits and buried at a Madison, Wis., municipal landfill site. Almost simultaneously, State and munici-

pal officials—Governors, mayors, public works directors plagued with trash-disposal and pollution problems—began coming to see its operation in conjunction with a City of Madison hammermilling plant that tears, breaks, and smashes mixed municipal refuse—glass, metals, cloth, plastics, and wood along with paper—into bits for more efficient and sanitary landfill disposal.

Of the 58 million tons of wood-pulp paper and paper products consumed in the United States in 1970, nearly 40 million tons disappeared in the Nation's trash.

The FPL recycling pilot project is designed to demonstrate the feasibility of separating wood fiber from other trash, segregating it into different types, and reusing it in the manufacture of wood fiber products. The objective, of course, is to reduce waste, lower trash disposal costs, retrieve increasingly scarce and valuable raw materials, and reduce pollution. Target products for reuse are panel products of various densities for structural fiberboards, wall paneling, insulation, and the like—long lived products with mass markets. Some fiber, of course, may go back to papermills.

Hammermilled trash is drawn into the pilot plant's air classifier—a device that directs carefully controlled air jets upward, lifting the lighter materials while the heavier drop. After passing through a cyclone to relieve air pressure, the lighter materials are conveyed to a screening device that sorts out larger from smaller pieces.

The recovered materials are then put through a series of fiberizing and washing operations to remove plastics, dirt, and other impurities. Again several grades of fiber are recovered—some suitable for paper, others for building materials. FPL research is concentrating on building materials.

Cooperating with FPL in solid waste research are the Bureau of Mines, Department of Interior, and the Environmental Protection Agency.

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SL 5110

A MACHINE RETRIEVES A TREASURE

Nationwide attention has been focused on FPL's pilot plant that experimentally separates paper from a mix of fragmented metal, glass, plastics, and other hammermilled refuse.

1. Air classifier (right background), cyclone for relieving air pressure (left background), and screening device (foreground).
2. Air jets inside classifier lift paper, other lightweight materials into a duct; glass, metals, other heavy materials fall out.
3. Paper moves on a conveyor to the screen.

FPL Low-Cost Housing Utilized Throughout the Nation

On the basis of a nationwide survey and other information, it has been conservatively estimated that thousands of houses will be built according to economical construction principles developed by FPL and incorporated in five house plans. The plans were drafted by FPL engineers and are sold at nominal cost by the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

The 1971 survey involved only persons requesting the plans when first announced in 1969. Questionnaires went to 1,620 persons, and 1,125 replied. More than 225 houses were reported to have been built. Several contractors had erected sizeable tracts and projected additional large numbers in subdivisions.

Construction cost figures supplied by those who had already built indicated that the price range targeted by FPL when designing the houses was being maintained at between $7,000 and $12,000. Prices varied mainly with size; floor plans range from 576 to 1,404 square feet in area. As expected, many plans were modified with extra-cost items such as basements, concrete instead of wood-post foundations, fireplaces, built-ins, and the like.

A number of the houses have been built in rural areas with financing by the Farmers Home Administration, which is available only when private financing cannot be obtained. This USDA agency administers housing loans at subsidized interest rates for low-income rural families under agreement with the U.S. Department of Housing and Urban Development.

FPL Housing Concepts In Operation Breakthrough

FPL's wealth of structural research experience, built upon 61 years of investigations ranging from the establishment of basic strength and related data to pioneering concepts for engineered wood structures, was brought into sharp focus on national housing problems during 1970-71.

Construction principles such as stressed-skin and sandwich evolved from FPL structural investigations came prominently to the fore in proposals submitted by builders for consideration in the Operation Breakthrough program of the U.S. Department of Housing and Urban Development. Of 24 Breakthrough proposals finally accepted for erection in various parts of the United States, FPL furnished technical evaluations for 17 involving wood to a major or minor extent. In some instances, analyses of fire risk, insulation adequacy, and other safety and structural aspects led to the use of wood instead of other materials specified in the original proposals. In two instances, additional confirmatory research was necessary to establish performance capabilities and design criteria for fabrications utilizing new adhesives. FPL also provided studies and consultations on the handling and shipping environment for housing in transit to insure safe delivery.

FPL has also been requested to evaluate the impact of such technological advances as the new American Lumber Standard sizes on structural strength and rigidity of housing, and on the use of new materials such as foam insulation on sandwich panel design.

5-Year Natural Finish Achieved for Houses

Long-term research that involved basic studies of radiation effects on wood and means of preventing them has culminated in an exterior clear-film natural finish with a life expectancy of at least 5 years instead of the 1 or 2 years associated with previous commercial formulations. The new FPL formulations hold promise of providing homeowners with exterior finishes that emphasize the beauty of their wood siding while assuring trouble-free performance comparable with that of high-quality paints.

The finish combines a silicone coating transparent to the destructive ultraviolet rays of sunshine, and therefore unaffected by photodegradation, with a treatment that protects the wood underneath from such degradation. Both copper chromate and copper chromate arsenate are among several compounds that provide the protection. Wood specimens exposed for more

LOW-COST RURAL HOUSING: A DREAM RESEARCH MADE REAL

In south central Wisconsin a local building contractor used FPL plans in erection of this house, financed by a low-interest loan of USDA's Farmers Home Administration. When completed, it would be occupied by a family with nine children who until then had called a drafty one-room-and-leanto their home. The two-story, five-bedroom structure was financed with an $11,500 loan to be repaid at $55 a month.

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than 5 years outdoors remain in good condition, free of the film loosening and hazing that occur in conventional clear-film natural finishes within a year or two as UV attacks the coating and finally the wood underneath.

Several copper compounds by themselves produce a stable brown color in wood and protect it from photodegradation, the research revealed. Clear silicone coatings on wood treated with these compounds remain in very good condition after 5 years of outdoor exposure. The compounds are ammoniacal copper oxide, copper pentachlorophenate, and copper molybdate.

Evidence is accumulating that copper or chromate ions may diffuse from the wood into conventional coatings, particularly polyurethane varnish, to protect them from photodegradation.

Nonpressure Treatment for Alaska Woods

Shutdown of Alaska's only pressure-treating plant has increased the need for effective nonpressure preservative treatments for Alaska woods used as piling, utility poles, fence posts, foundation timbers, and other products requiring protection from decay and wood-attacking insects. A modified double diffusion process is showing excellent prospects of meeting this need.

White spruce, Sitka spruce, mountain hemlock, and balsam poplar were successfully treated by a modification of FPL's double diffusion treatment that includes hot and cold baths, partial seasoning, and incising. Good penetrations and retentions were obtained with all four species. A pilot study will be conducted at Palmer, Alaska in the spring of 1972 by FPL specialists in cooperation with the University of Alaska. White spruce, balsam poplar, and paper birch will be treated.

Technician Harley Davidson and chemist Henry Roth spray with a color reagent samples of balsam poplar treated by modified double diffusion. The reagent establishes depth of preservative penetration. The bright blue hue indicates presence of copper. SL 4189

New Structural Test Frame for Engineered Housing

For the first time it is possible for FPL scientists to evaluate a modular assembly of floor, walls, and roof stressed by typical live and dead loads to determine composite performance. Information essential for the more efficient structural design of houses will be developed from experiments with a new structural test frame.

Although admittedly only a stopgap until more complete facilities can be obtained, the structural test frame is yielding highly useful information on the strength and related performance capabilities of various engineered structural components. It was built to test structural assemblies up to 12 feet wide, 24 feet long, and 10 feet high—about half of a small house with a low-pitched roof.

Uniform loading is applied by means of pneumatically inflated air bags capable of applying up to 500 pounds per square foot. This far exceeds any design load requirements for houses, as well as any anticipated natural or man-made forces such as hurricane winds or deep snows. Even the most violent hurricanes rarely exceed forces greater than 40 pounds per square foot on a single-story house wall, nor is the weight of accumulated snow likely to exceed 35 pounds per square foot in most regions of the continental United States. Code requirements for combined live and dead loads on house floors are generally about 50 pounds per square foot.

The structural test frame is expected to prove particularly useful for evaluating hous-

ing systems. It will also be useful for evaluating new housing design concepts developed for use in Operation Breakthrough, the program developed by the U.S. Department of Housing and Urban Development. FPL has been designated the official agency for evaluating systems of wood and wood-base materials proposed for that program.

The electronic data retrieval system is capable of receiving electronic signals from 100 strain gages, load cells, displacement transducers, and other devices for measuring movements of a test specimen induced by load forces. The signals are read by a scanner and converted by a calculator into engineering units of force and displacement needed for design evaluations.

Built mainly of heavy steel I-beams and I-columns, FPL's new structural test frame is yielding vital information about engineered housing concepts — information unobtainable by conventional test methods. Load is applied by air compressed in plastic bags. Electronic sensing devices flash signals continuously to a calculator that converts them to engineering data needed for structural evaluations.

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Chemical Treatments Halt Deterioration of Stored Chips

Two promising treatments for preservation of pulp chips stored outdoors in large piles are under investigation at a southern pulpmill after successful pilot-scale trials in the laboratory. One treatment consists of immersing chips in kraft green liquor. This liquor is found

in the recovery cycle of kraft pulpmills and consists mainly of sodium sulfide and sodium carbonate. A U.S. public use patent is pending on this treatment. The other treatment consists of immersing the chips in a dilute solution of sodium N-methyldithiocarbamate. The objective of the treatments is two-fold: to prevent loss of wood by fungal deterioration and loss of extractives that yield valuable chemical byproducts of kraft pulping.

The outdoor trial at the kraft mill of the cooperating Westvaco Company near North Charleston, S.C., began in October 1971 with the construction of three piles of loblolly pine chips. One pile contains chips treated with green liquor, the second is untreated, and the third contains chips treated with sodium N-methyldithiocarbamate. Sample chips will be removed from each pile and evaluated for loss of wood and extractives.

The outdoor tests were preceded by extensive pilot-plant evaluations of green liquor, sodium N-methyldithiocarbamate, and other chemicals. Green liquor and sodium N-methyldithiocarbamate showed high promise in these experiments.

Cooperators in the tests, besides Westvaco, are the Fourdrinier Kraft Board Institute and the Stauffer Chemical Company, producer of the sodium N-methyldithiocarbamate used in these tests.

FROM SPENT KRAFT LIQUORS, A TREATMENT FOR STORED CHIPS:

1. Chips get bath in protective chemical.
2. Treated chips are stored in insulated towers that simulate outdoor pile conditions.
3. Chips being treated for outdoor storage at a South Carolina mill.
4. Piles of loblolly pine chips test treatments under actual use conditions.

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Nondestructive Testing Progress

As a general rule, softwood construction lumber is visually graded as it comes from the planer. The grade assigned a piece depends on the size and distribution of such defects as knots, cross grain, splits, and checks. That visual grading works is due in no small part to research that has established reasonably reliable relationships between defects and strength impairment. Nevertheless, because it is by no means foolproof, allowable stresses are based on heavy penalties for the relatively few exceptionally weak pieces that cannot be sorted out by visual methods. Overall, studies have shown that some 40 to 50 percent of the strength of much lumber is disregarded because of the ineffciency inherent in this grading method.

Realization of this penalty has prompted scientists and industry to experiment with other quality-assessment methods. So-called stress-rating machines have been developed that permit estimates of strength and stiffness —a critical factor in load-bearing members such as joists and rafters—on the basis of deflections induced at low loadings. Only modest commercial use of mechanical grading has taken place. In line with more efficient resource utilization, FPL encourages implementation of mechanical grading.

FPL research is aimed at elucidating the

Research on nondestructive lumber grading includes experiments with this device which computes modulus of elasticity from vibrations set up in a piece by finger pressure. Engineer Andrew J. Kass uses it here to measure stiffness of 2-inch framing lumber.

SL 1168

basic principles of stress grading. Distinct progress has been attained by considering not one single property but several in combination, in attempts to account for higher proportions of strength and stiffness. A recent study of tensile strength demonstrates the possibilities of gaining more rational design stresses. Structural lumber varies greatly in tensile strength, a critical component of the load-carrying capacity of trusses, laminated beams, and other structural members.

Results of tensile evaluation of several hundred 2 by 4s and 2 by 8s showed that 72 to 83 percent of the tensile strength can be accounted for by various linear combinations of knot strength ratio, stiffness, slope of grain, and specific gravity. Knot strength ratio and stiffness appear to be the most significant variables.

If grading methods can be developed that will permit isolation of the few low-strength pieces in each visual grade, a considerable increase in allowable tensile stresses can be realized. Utilization efficiency would increase likewise in applications where tensile stress controls design.

New Standard for Softwood Lumber

A new American Softwood Lumber Standard (PS20-70) became fully effective under the U.S. Department of Commerce voluntary product standard program September 1, 1970. It marked the culmination of many years of effort by the American Lumber Standard Committee, to which FPL furnished a technical adviser who participated in its deliberations. The new standard covers softwood lumber sizes, grades, grademarking, and inspection.

Some of the fundamental improvements incorporated have long been advocated by FPL. For the first time, the standard relates lumber sizes to moisture content. Green lumber sizes are required to be larger than those for seasoned lumber, thus assuring that sizes—and strength—will be more nearly uniform when the lumber comes to equilibrium with humidity conditions in service. Also, 2- to 4-inch-thick lumber has uniform grade restrictions over the entire length as a new requirement.

FPL is designated by the standard as the agency to review regional association grading rules for conformity with it.

Enzyme Eases Preservative Entry Into Poles

Pectinase, a widely used clarifying agent for fruit juices, may also find commercial use in improving the preservative treatability of some species, such as Rocky Mountain Douglas-fir, that are notoriously hard to impregnate. Experiments have demonstrated conclusively that this enzyme unblocks openings in the cell walls that become plugged as the wood dries—a condition known as aspiration. Pectinase does this by eroding the blocking tissue, called a torus, thus effectively deaspirating the pit opening.

Green logs are treated with the pectinase solution under pressure, then stored in moisture-tight plastic films for 3 weeks to allow the enzyme to act on the tori of aspirated pits, after which the logs are allowed to dry. Preservative treatment not only penetrate the enzyme-treated wood much more deeply but leaves the surfaces of logs much cleaner.

Nonpollutive Pulping Outlook Brightened by Oxygen Process

Experimental progress on a sulfur-free pulp process based on molecular oxygen and organic hydroperoxides has clearly demonstrated that it has definite potential as a successor to kraft for production of strong pulps—and free of the sulfides and other pollutive byproducts of the latter process.

High yields of clean, bright pulps have been obtained from aspen, a widely used hardwood, and southern pines, the mainstay of the South's pulp and paper industry. Spent oxygen liquors were free of obnoxious odors. Dissolved organics were found to consist mainly of aromatic carboxylic acids from which useful chemicals are possible before the mixture is incinerated to recover sodium bicarbonate for reuse; there-

by, much otherwise pollutive residue is utilized. Brightness of the pulps compared with characteristically brown kraft might eliminate conventional bleaching with its associated pollution.

Means of overcoming excessive oxidative degradation of the cellulose, which weakens the pulps, appear possible. Combinations of magnesium salts and potassium iodide afford some protection to the cellulose.

Hydroperoxides are used because molecular oxygen alone has very low solubility and therefore does not penetrate wood as well as desired. Cost of hydroperoxides, however, at present severely limits the commercial feasibility of the process. Chemical alternatives are being investigated.

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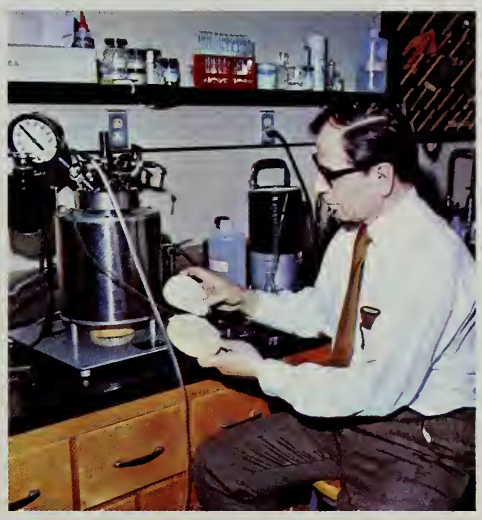

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"Cooking" wood to pulp with oxygen

1. Technician Harland Wallace removes a pressure cylinder containing oxygen-pulped wood from apparatus used to circulate pulping liquor through it while in a heated oil bath.

2. Contents of cylinder are emptied into a beaker.
3. Dr. Necmi Sanyer, chemist in charge of oxygen pulping research, examines pulps obtained from two digestions.

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Pectinase treatment renders hard-to-treat woods like Rocky Mountain Douglas-fir much more penetrable by preservative. Upper photo shows clean, dry surface of pectinase-treated log as compared with oily surface of an untreated log after both were pressure-impregnated with preservative. Lower photos show, left, deep penetration of preservative into pectinase-treated log as compared with shallow penetration into an untreated log.

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FPL Termite Poison Lure Decimates Colonies

Strong evidence of the way in which FPL's termite attractant-insecticide decimates colonies of these wood-destroying insects has been obtained from studies of termite behavior. The method consists of putting treated wood wafers 5 feet apart in the soil around a building, like miniature sentinels. Worker termites pick up poisoned wood from the wafers, to which they are lured by the attractant, and carry it back to the nest. There they die, and when enough are killed the delicately balanced caste structure of the colony is disrupted, leading to abnormal developments that inflict further mortality. Nest sanitation deteriorates, and mold fungi, mites, and other detrimental organisms flourish, contributing to the colony's destruction.

An outstanding ecological advantage of the method is that it requires only very small amounts of toxic chemicals compared with conventional soil treatments around houses. Effectiveness of the treatment as a remedial method is now being tried experimentally in Hawaii on the highly destructive Formosan termite and in Rhode Island on our native species.

Livestock Feed From Pulpmill, Sawmill Wastes

Satisfaction of our current demands for paper and paperboard products calls for an annual production of some 40 million tons of woodpulp fibers. Nearly 2 million tons are lost in papermaking—to be disposed of by burning, landfill, or stream ejection. These residues run the gamut from totally lignified groundwood fines to fully pulped and bleached chemical pulp fines of essentially pure cellulose. Laboratory assays, using digestive juices from a fistulated cow, have indicated a similar range in feeding value—many of the residues providing the energy equivalence of a medium quality hay and a few even exceeding that of corn. Preliminary feeding trials with goats have fully verified the laboratory results. More extensive trials are now under way with sheep and cattle to study the long-range effects of high pulp-waste rations and to develop the basic information needed for qualifying such residues as a useful feedstuff for livestock.

Untreated sawdust, though of negligible feed value, has been shown to be a suitable roughage substitute for livestock, including both beef and dairy cattle, goats, and sheep. It functions as a saliva stimulant, as does hay, thereby helping allay stomach and liver damage commonly encountered in ruminants being fed high-concentrate diets at feedlots. Feeding tests at the University of Wisconsin, Penn State, and Auburn Universities, and at a commercial feedlot demonstrated the practicality of feeding pelletized concentrates that contained varying proportions of sawdust in place of hay meal. More extensive feeding trials at a commercial feedlot are in the offing.

Sheep feeding on carbohydrate-rich fines screened from pulp at a tissue mill. SL 2044

FPL Grade-Yield Charts Extend Walnut Supplies

Black walnut, most prized of our native hardwoods, can now be used more economically by means of FPL's new grade-yield charts specifically devised for the unique National Hardwood Lumber Association rules used to grade this species.

The charts for walnut are an adaptation of charts previously devised for hard maple and

generally applicable to all hardwoods except walnut, grading rules for which differ substantially from regular NHLA rules. The walnut charts are published in U.S. Department of Agriculture, Forest Service Research Paper FPL 162, those for other hardwoods in FPL 118. The charts should prove especially useful to manufacturers of furniture and dimension stock when estimating, for a given cutting list, the yields possible from each of the four grades of this species. The most economical grade can thus be determined. Two charts are provided for each grade, one applicable to cuttings 1 inch wide and the other to cuttings 1½ to 5½ inches wide.

Unbarked Young Trees Practical for Pulp

Cottonwood trees 1 to 3 years old, grown under conditions that accelerated growth as much as tenfold, were chipped without removing bark and pulped by the kraft process, with intriguing results. Burst and tensile strength were about the same as for pulp made of more mature trees—11 and 24 years old—grown under similar conditions by University of Wisconsin silviculturists; tear strength was about 80 percent that of pulps from the older trees. Trees 3 and 5 years old were also experimented with. Comparable findings were obtained from experiments with fast-grown young sycamore obtained from the Southeastern Forest Experiment Station.

The results indicate that cropping of trees only a few years old may prove feasible for the production of pulps useful for products in which the soft juvenile fibers are desirable. Bark fibers not dissolved during digestion blend in acceptably with these fibers for tissues and similar products, so that bark removal becomes unnecessary.

Sycamore saplings are chipped by Technician Erwin Elert for experiments in pulping of unbarked, fast-grown wood. SL 5099 SL 5100

Warp-Free Red Pine Studs

Studs sawn by an FPL method from small fast-grown logs of plantation red pine warp less than those sawn by either of two methods used in the industry. Moreover, more of the studs produced by the FPL method meet the "stud grade" specifications of the new National Grading rule. FPL's method is an improvement on the Scragg method of sawing logs now in

use. It had previously been successfully tried with loblolly pine and lodgepole pine. Large volumes of red pine from plantations in the Lake States and Northeast are beginning to come on the market.

Studs sawn from 12-inch butt logs by the FPL-improved Scragg method had 35 percent less warp than those sawn by the regular Scragg method and 63 percent less than studs sawn by the conventional method of log breakdown. Stud grade recovery with the FPL method was 6.5 percent greater than by the regular Scragg method and 19.6 percent higher than by the conventional method.

Warp-Free Hard Maple Cuttings

Nearly twice as many planed, warp-free clear cuttings were obtained from boards produced from hard maple logs by a method of sawing "around the log" called grade sawing than from boards produced by a "through-and-through" sawing method called live sawing. The cuttings had been planed to the standard finished thickness called for by rules of the National Hardwood Dimension Manufacturers Association. The grade-sawing method yielded 44 percent of the surface area in clear cuttings free of warp and the live-sawing method 24 percent. When material salvaged from the warped cuttings was included, total loss due to warp was 15 percent for the grade-sawing method and 25 percent for the live-sawing method.

Mycology Research Center Now at FPL

FPL itself acquired a new dimension in 1971 with the establishment of a Center for Forest Mycology Research. The Center evolved from the Forest Service's Forest Disease Laboratory, which was transferred from Laurel, Md., complete with staff, facilities, and fungus cultures. The move brought closer together FPL's long-time research on fungi that cause wood in service to rot with the Laurel Laboratory's investigations of the life cycles and related information on fungi that exist in association with trees.

The Center is one of three in the world where pure cultures of fungi are maintained and available for study; others are in Ottawa, Canada, and Baarn, The Netherlands.

FPL--Some Ways to Use It

In the six decades of its existence, FPL has been utilized by citizens in virtually every walk of life—businessmen, farmers, craftsmen, government officials, practitioners of medicine and the law, police, artists and art collectors, teachers, students, homeowners, and housewives. No matter what your occupation, your life, too, is affected in a multitude of ways by the availability and serviceability of wood products. The great and diverse store of knowledge accumulated by FPL since 1910 is generally at your disposal.

Perhaps you need only write a letter. In 1971 some 100,000 letters propounding a wide range of questions about wood were answered by FPL specialists.

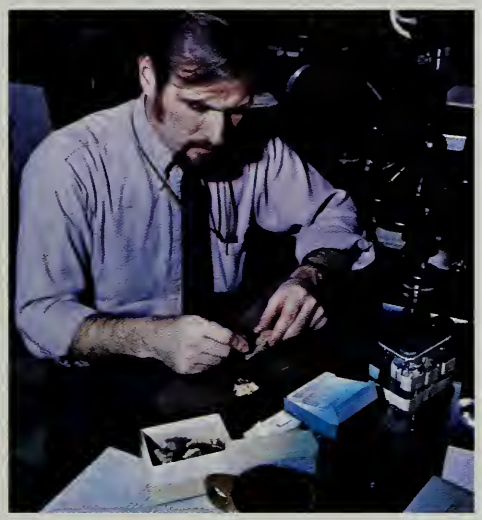
Or you may want to visit us. In 1971, a total of some 11,400 men, women, and youngsters did just that. They came from nearly all States and half a hundred foreign countries. About a third were classified as "consulting"—that is, people with specific technical problems, or participants in technical meetings. But most came for tours of the Laboratory, either the regular one that starts daily at 2 p.m. or specially arranged ones for students and other groups.

FPL has issued many publications over the past 60 years. Among recent ones are Agriculture Handbook No. 73, "Wood-Frame House Construction," and Agriculture Handbook No. 402, "Air Drying of Lumber: A Guide to Industry Practices."

Each year a number of research papers, research notes, reprints of articles published in scientific journals, and other types of reports are added to the FPL lists of available publications. Technical people wanting our semiannual lists of reports are invited to send their names and addresses.

FPL'S NEW FOREST MYCOLOGY CENTER AT WORK

1. Dr. Harold Burdsall prepares fungus specimen for microscopic examination.
2. Dr. John G. Palmer, Center leader, examines a growth of mycorrhizae fungus on **Populus** root.
3. Tereas Scotton inoculates a fungus in pure culture.
4. Frances Lombard maintains the reference culture collection, kept in refrigerators at 12° C.
5. Typical forest fungus, **Conophora olivaceae,** on a spruce log.
6. John Lindsay examines a flask containing fungus grown on specially prepared nutrient.



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Dr. Mirko Ilic (right) of the Institute of Wood Technology, Sarajevo, Yugoslavia, spent some months at FPL during 1971 for cooperative research to overcome seasoning difficulties in the production of high-quality beech hardwood dimension from youngwood and branchwood as well as mature stem logs. Shown here with Dr. H. O. Fleischer, FPL director, he will conduct research at Sarajevo financed by Public Law 480 funds derived from the sale of U.S. agricultural products to his native land.

FPL participated in a 1970 United Nations Food and Agriculture Organization meeting on wood-base panel products in Rome, Italy, and the July, 1971, FAO Consultation on the Use of Wood in Housing at Vancouver, B.C. Innovations in worldwide use of wood for construction were reviewed by some 50 scientists from 16 foreign countries who participated in sessions of three working groups of the Forest Products Section, International Union of Forestry Research Organizations, at FPL in March 1971.

The impact of new cultural techniques such as fertilization and irrigation on wood quality was examined at an FPL symposium jointly sponsored with a committee of the American Paper Institute and the Technical Association of the Pulp and Paper Industry in November 1971. Some 130 representatives of industry, forestry schools, and research laboratories heard 15 speakers report on research dealing with the effects on wood of such techniques as short rotations and growth stimulation.

Every year, FPL specialists participate in programs of such organizations as the American Chemical Society, the Forest Products Research Society, the American Society for Testing and Materials, the Technical Association of the Pulp and Paper Industry, and the United Nations Food and Agriculture Organization.

Numerous technical and trade organizations send groups to FPL to discuss application of research results and technological problems of their industries. Among these are representatives of the National Forest Products Association, the American Plywood Association, and committees of the American Paper Institute, the Technical Association of the Pulp and Paper Industry, the American Society for Testing and Materials, American Railway Engineering Association, American Wood-Preservers' Association, the National Woodwork Manufacturers Association, and the Pulp Chemicals Association.

Some 100 scientists and engineers attended a symposium on research to improve design of light-frame construction in February 1970, and in October of 1970 and 1971 Yale University's thirty-fifth and thirty-sixth Industrial Forestry Seminars were held at FPL.

Over the years, FPL has acquired many public use patents available for license from the Secretary of Agriculture.

If you are a college student interested in

Among scientific and industrial bodies that met at FPL during the past two years was Committee D-7 on Wood of the American Society for Testing and Materials, which promulgates industry standards on a wide range of materials, treatments, and processes. FPL staffers have been active for many years in the Society's committees and offices, including the presidency.

Checks, merit certificates, and more complex assignments went to these two student summer employes at FPL when they completed an assignment in much iess time than had been expected. Harold Mitchell, left, chief of Wood Quality Research, presented the awards to Richard Gerbitz and Robin Zeldin for completing in record time specific gravity measurements of some 3,000 specimens of wood from Wisconsin forest trees as part of a wood quality survey of standing timber. M 139 883

A public patent was granted covering FPL's ultrasonic process for sensing defects in flitches — a significant breakthrough toward automation of the sawmilling industry. The technique senses defects by analyzing the time interval between two ultrasonic transducers. Since sound travels faster along the grain than perpendicularly through it, knots, for example, can be differentiated from clear wood. The technique is a basic part of a system which can sense and locate defects in flitches as they come from logs in a sawmill, make a computer decision to obtain maximum yield from the flitch, and then control the edging and trimming saws to process the flitch.

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Aerial view of the U.S. Forest Products Laboratory main building and, upper right, buildings for fiber and chemistry-wood protection research. Several smaller buildings are not shown, including laboratories for packaging and wood combustion research.

forest products research, the opportunity to spend the summer at FPL working on some research assignment may appeal to you. Each year up to 20 young men and women take advantage of it.

FPL's longtime research on wood indentification and anatomy was reorganized as a Center for Wood Anatomy Research. The services of this Center are familiar to wood products producers and buyers, importers, and government officials as well as crime investigators, archeologists, museum directors, sellers and buyers of antiques, woodworkers, artists, and the public generally—all of whom make use of its free wood indentification facilities. Dr. B. F. Kukachka, the Center's leader, spent eight weeks in Bogor and Jogjakarta, Indonesia, teaching wood anatomy and identification at two universities. His assignment was sponsored by the Midwest Universities Consortium for International Activities with a grant of funds from the Agency of International Development.

The Smithsonian Institution of Washington, D.C., sent FPL bits of wood from this Revolutionary War gunboat, resurrected in 1935 from Lake Champlain, where it had been sunk in 1776 by superior British forces. The Philadelphia, oldest man-of-war on exhibit in North America, was one of 17 vessels built by Benedict Arnold's men that summer from lakeshore timber. They fought a British flotilla of 53 vessels, delaying a British attack on Fort Ticonderoga until the following year. when it failed. The Philadelphia, FPL study showed, had white oak frames and planking, white pine mast and spars, and other parts of white ash, hophornbeam, white-cedar, and lignumvitae. (Photo courtesy Smithsonian Institution)

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish and other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticide and pesticide containers.

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